Appl. No.: 10/606,131
Reply to Office Action of: 08/10/2006



Remarks

Claims 1, 4, 6-10, 17 and 21 were rejected under 35 U.S.C. §103(a) as being unpatentable over Sumiyoshi et al. (JP 2002-23156) in view of Moon (US 6,778,238). EP 1312972 is the EP equivalent of JP 2002-23156. Claim 2 was rejected under 35 U.S.C. §103(a) as being unpatentable over Sumiyoshi et al. (JP 2002-23156) in view of Moon (US 6,778,238) and Nakamura et al. (US 5,508,831). Claim 11 was rejected under 35 U.S.C. §103(a) as being unpatentable over Sumiyoshi et al. (JP 2002-23156) in view of Moon (US 6,778,238) and Yamahara et al. (US 5,506,706). Claim 12 was rejected under 35 U.S.C. §103(a) as being unpatentable over Sumiyoshi et al. (JP 2002-23156) in view of Moon (US 6,778,238) and Cornelissen et al. (US 6,437,900). Claim 20 was rejected under 35 U.S.C. §103(a) as being unpatentable over Sumiyoshi et al. (JP 2002-23156) in view of Moon (US 6,778,238) and Beiswenger et al. (US 4,958,911). The examiner is requested to reconsider these rejections.

Enclosed is an English language translation of Sumiyoshi et al. (JP 2002-23156).

Claim 2 has been cancelled without prejudice and its features have been added to claim 1.

Sumiyoshi discloses a liquid crystal display device that contains an LCD layer 1 and a three layer staked holographic polymer dispersed liquid crystal (HPDLC) 17. Transparent electrodes are positioned above and below the LCD layer 1 (not shown in figures). Transparent electrodes 26 are positioned above and below HPDLC 17.

Sumiyoshi discloses that LCD 1 has its own pair of electrodes and HPDLC 17 has its own pair of electrodes 26. Sumiyoshi discloses that each of the LCD layer 1 and the HPDLC layer 17 is individually controlled by their own respective pairs of electrodes. Therefore, there is no disclosure in Sumiyoshi of a liquid crystal layer and a switchable optical layer sharing an electrode as in claim 1.

Claim 1 is, therefore, novel over Sumiyoshi. Claim 21 is novel over Sumiyoshi for similar reasons to those set out for claim 1.

There would be no motivation to modify Sumiyoshi to provide an electrode that is shared by the switchable optical layer and the liquid crystal layer. Sumiyoshi teaches that the reflectance of the three-layer stacked HPDLC layer 17 is high when voltage is not applied. In this embodiment of Sumiyoshi, display operation is enabled by supplying a voltage to only liquid crystal layer 1 without supplying voltage to three-layer stacked HPDLC layer 17. Extra power is not needed during reflective display. Sumiyoshi teaches that the LCD layer and the HPDLC layer are controlled separately by their individual pairs of electrodes. It would not be possible to modify Sumiyoshi to have an electrode shared by the LCD layer and the HPDLC layer because Sumiyoshi would then not operate in the manner described, as it would not be possible to supply voltage to the LCD layer without also supplying voltage to the HPDLC layer.

Moon discloses a reflective liquid crystal display device that contains a liquid crystal layer 130, a common electrode 156

beneath the liquid crystal layer, pixel electrodes 112 positioned above the liquid crystal layer and reflective cholesteric liquid crystal (CLC) filter layer 152 positioned beneath the liquid crystal layer and the electrodes.

Moon does not disclose the claimed switchable optical layer. Moon also fails to disclose an electrode shared by a liquid crystal layer and a switchable optical layer.

There would be no motivation to combine the teachings of Sumiyoshi and Moon, because Moon is only related to a reflective liquid crystal display device and is not related to having a layer that is switchable between transparent and reflective states.

As Moon fails to rectify the deficiencies of Sumiyoshi, even if the documents were combined, the combination would still not fall within the scope of the claimed invention.

In the office action, the examiner has rejected claim 2 by alleging that it is obvious in view of Sumiyoshi, Moon and US 5,508,831 (Nakamura). The Examiner alleges that Nakamura discloses an electrode that is shared by the liquid crystal layer and the switchable optical layer.

Nakamura discloses a liquid crystal display panel that has a liquid crystal layer 14 arranged between a pair of glass plates and a colour filter arranged on one of the plates.

Nakamura discloses a liquid crystal layer 14 that has a fist layer 18 and a second layer 20 and electrodes that are shared between the first and second layers. Nakamura does not disclose the claimed switchable optical layer. Nakamura also

does not disclose an electrode that is shared by a switchable optical layer and a liquid crystal layer.

There would be no motivation to combine the teachings of Sumiyoshi and Nakamura, because Nakamura is related improving the contrast and number of colours that can be displayed. Nakamura is not related to providing a liquid crystal display that can operate in both transmissive and reflective modes.

As Nakamura fails to rectify the deficiencies of Sumiyoshi, even if the documents were combined, the combination would still not fall within the scope of the claimed invention.

Embodiments of the present invention as defined by the independent claims are, therefore, non-obvious in view of the prior art.

For all of the foregoing reasons, it is respectfully submitted that all of the claims now present in the application are clearly novel and patentable over the prior art of record. Accordingly, favorable reconsideration and allowance is respectfully requested. Should any unresolved issue remain, the examiner is invited to call applicant's attorney at the telephone number indicated below.

Respectfully submitted,

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2/15/07
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# PATENT ABSTRACTS OF JAPAN

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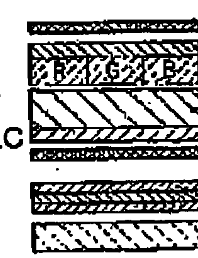
## (54) LIQUID CRYSTAL DISPLAY DEVICE

(57)Abstract:
PROBLEM TO BE SOLVED: To realize a full color reflective display and a full color transmissive display without lowering reflectance and transmittance by using Bragg reflection.

SOLUTION: The liquid crystal display device is provided with: a first polarizing plate 16a; a color filter layer 6 formed with a color filter substrate 15 disposed on the upper layer side; a liquid crystal layer 1 formed on a glass 18, a second polarizing plate 16b; a laminated HPDLC (holographic polymer dispersed liquid crystal) 17 consisting of three layers which is a reflection structure layer whose reflectance can be electrically switched and which is disposed on the lower layer side than the liquid crystal layer 1; and a backlight unit 3 as the lowermost layer. The individual layers of the laminated HPDLC 17 consisting of the three layers are composed of liquid drop layers of the liquid crystal and polymer layers and reflect blue, green and red light by Bragg reflection. Voltage application to the laminated HPDLC layer 17 consisting of the three layers results in variation of the refractive indexes of the liquid drop layers of the liquid crystal in the individual layers. A transparent state is attained by making refractive indexes of the liquid drop layer of the liquid crystal and the polymer layer coincide with each other.

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1.This document has been translated by computer. So the translation may not reflect the original precisely.
2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

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DETAILED DESCRIPTION

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[Detailed Description of the Invention]
[0001]
[Field of the Invention] This invention relates to the liquid crystal display which displays information.
[0002]
[Description of the Prior Art] A reflective mold liquid crystal display is widely used for a portable way for a low power. Especially, the reflective mold liquid crystal display which can be displayed full color has come to be developed.
[0003] The reflective mold liquid crystal display uses the ambient light as the light source, under outdoor sunlight, it is possible to express as image quality high under outdoor sunlight, on the other hand its thing with bad visibility is [ a transparency mold liquid crystal display has low contrast, and ] common. However, in the interior of a room without the outdoors or the special lighting of Nighttime, the visibility of a reflective mold liquid crystal display is bad, and image quality like a transparency mold liquid crystal display is not acquired.
[0004] So, in the bright environment, it can display as a reflective mold and the liquid crystal display which can be displayed by the addition light source is called for in the dark environment. A transflective LCD can be mentioned as this example. This transflective LCD makes a transflective side the reflector in which incident light is reflected. However, for example by the display by the transflective side of 50% of permeability, and 50% of reflection factors, it is dark at the time of a reflective display, and has the fault of being dark, also at the time of a transparency display.
[0005] as what conquers the above faults -- JP,11-119026,A -- reflection and transparency -- the switchable liquid crystal display is indicated. The typical sectional side elevation of a liquid crystal display which has a hologram reflecting layer in drawing 13 is shown. As shown in drawing 13 , the hologram reflecting layer 528 which is a volume hologram is arranged between the back light unit 503 and the liquid crystal layer 501.
[0006] This volume hologram is the structure which has a fixed refractive-index modulation, and if this modulation period is visible wavelength extent, the diffraction called Bragg reflection will arise and it will reflect strongly the light of wavelength with a certain incident angle in a specific direction. The circle graphic form which shows this relation to drawing 14 explains. The radius of a circle shown in drawing 14 (a) is given by n/lambda. Here, lambda is the wavelength of incident light and n is the average refractive index of a hologram medium. Incident light is expressed with the vector from a core to a circle top to this circle. The incident wave numerical vector 529 and reciprocal vectors 531 are arranged like drawing 14 (a). Here, reciprocal vectors 531 are defined and the modulation direction of a refraction modulation of the direction and the magnitude of a vector are defined by the inverse number of a modulation period. In drawing 14 (a), the outgoing radiation wave number vector 530 is displayed as a difference of the incident wave numerical vector 529 and reciprocal vectors 531. Light is strongly reflected in the direction of this outgoing radiation wave number vector 530.
[0007] Next, drawing 14 (b) explains reflective actuation. The back light unit 503 does not use at the time of a reflective display, but displays on it only by incident light. The incident light from a perimeter carries out incidence to the liquid crystal layer 501, and incidence is carried out to the hologram reflecting layer 528. If the reciprocal vectors of the hologram reflecting layer 528 are arranged as shown in drawing 14 (b), selective reflection only of the specific wavelength will be carried out in the direction of specific outgoing radiation. The light by which selective reflection was carried out passes the liquid crystal layer 501 again, and the reflective display of it is attained. Light other than this wavelength that carries out selective reflection does not contribute to a display in order to pass the hologram reflecting layer 528.
[0008] On the other hand, a back light is made to turn on when a surrounding environment is dark. In this case, the light from a back light passes the hologram reflecting layer 528, and it carries out incidence to the liquid crystal layer 501. This can be made to perform a transparency mold display as shown in drawing 14 (c).
[0009] If the liquid crystal display indicated by JP,11-119026,A as mentioned above is used, reflection / transparency

:hange display will be attained.

[0010]

[Problem(s) to be Solved by the Invention] However, in the liquid crystal display indicated by JP,11-119026,A mentioned above, it has the problem that the foreground color at the time of a reflective display differs from the foreground color at the time of a transparency display. That is, as shown in drawing 14 (b), in the time of a reflective display, only the light of the specific wavelength decided by the hologram reflects. For this reason, only monochromatic specification is possible at the time of a reflective display. Furthermore, in the time of a transparency display, as shown in drawing 14 (c), Bragg reflection of the specific wavelength of back light light will be carried out by the hologram, and it cannot be contributed to a transparency mold display. This wavelength that carries out Bragg reflection is the same as the wavelength of the homogeneous light at the time of a reflective display. For this reason, even if it is green at the time of a reflective display and can be displaying on it for example, at the time of a transparency display, it must display with that complementary color. Moreover, a full color display cannot be made to perform for the same reason, either.

[0011] As mentioned above, although the liquid crystal display indicated by JP,11-119026,A realizes reflection / transparency display change display, color display is restricted and it has the technical problem that it does not indicate by full color.

[0012] Then, this invention aims at offering the liquid crystal display using the Bragg reflection which can perform a full color transparency display for a full color reflective display in a dark environment in a bright environment.

[0013]

[Means for Solving the Problem] In order to attain the above-mentioned purpose, the liquid crystal display of this invention is characterized by having the back light unit arranged at the liquid crystal layer, the reflective structure layer by which the reflection factor of each of said reflective section is electrically arranged rather than said switchable liquid crystal layer at the lower layer including two or more reflective sections which reflect only the light of a specific frequency band by Bragg reflection, and the lowest layer which irradiates light from a tooth back at said liquid crystal layer.

[0014] The reflection factor of each reflective section has the switchable reflective structure layer electrically including two or more reflective sections in which the liquid crystal display of this invention constituted as above-mentioned reflects only the light of a specific frequency band in a lower layer by Bragg reflection rather than a liquid crystal layer. namely, reflection and transparency brighter than the liquid crystal display using a transflective side in using Bragg reflection -- it becomes a switchable liquid crystal display. Furthermore, only the light of a specific frequency band is reflected for each reflective section of a reflective structure layer by Bragg reflection, for example, the full color display only of blue is attained with only reflection, green chisel reflection, and red constituting like reflection in each of each reflective section.

[0015] Moreover, at least one thickness of the substrate which pinches the liquid crystal layer of the liquid crystal display of this invention may be the thickness which does not produce parallax, and this substrate may be thin film-ized glass and may be a film substrate.

[0016] Moreover, the liquid crystal display of this invention may have the 1st color filter layer arranged rather than the liquid crystal layer at the upper layer, and may have further the 2nd color filter layer arranged rather than the reflective structure layer at the lower layer. At the time of a reflective display, a high reflection factor is obtained in the thing of the property of the low color purity in high permeability by using the thing of the property of the low color purity in high permeability as 2nd color filter layer, and the property that high color purity is obtained can be given at the time of a transparency display as the case of a configuration of having the 2nd color filter layer especially in addition to the 1st color filter layer, for example, 1st color filter layer.

[0017] Moreover, to the reflective structure layer, the laminating of each reflective section may be carried out in the direction of a laminating in which the laminating of a liquid crystal layer and the back light unit is carried out, and it may be formed in it.

[0018] Furthermore, each reflective section may be arranged by juxtaposition in the direction which carries out an abbreviation rectangular cross in the direction of a laminating in which the laminating of a liquid crystal layer and the back light unit is carried out to a reflective structure layer. In this case, since a full color display is attained without preparing a color filter when each reflective section which reflects blue, green, and red has been arranged at juxtaposition, a liquid crystal display with easy structure can be obtained brightly.

[0019] Moreover, it may contain liquid crystal, and especially, each reflective section may contain cholesteric liquid crystal, and you may be the structure where the laminating of at least one liquid crystal drop layer containing the drop of liquid crystal and at least one macromolecule layer was carried out by turns, and it may consist of a macromolecule layer containing the drop of cholesteric liquid crystal.

0020] Moreover, the liquid crystal display of this invention may have the 1st polarizing plate arranged rather than the iquid crystal layer at the upper layer, and may have the 2nd polarizing plate arranged rather than the liquid crystal layer at he lower layer. By using a compensating plate, it becomes possible to use display devices, such as STN LCD other than [N liquid crystal, and birefringence liquid crystal, as a liquid crystal display component.
0021] Moreover, you may have the compensating plate with which the liquid crystal display of this invention is arranged ather than the 1st polarizing plate at a lower layer, and is arranged rather than the 2nd polarizing plate at the upper layer ınd with which phase contrast is compensated, and the compensating plate may be arranged rather than the reflective structure layer at the upper layer.
0022] Moreover, the active-matrix drive of the liquid crystal layer may be carried out.
0023]
Embodiment of the Invention] Next, the gestalt of operation of this invention is explained with reference to a drawing. In addition, in explanation of each operation gestalt, holographic macromolecule distribution liquid crystal expresses HPDLC.
1st operation gestalt) Next, the sectional side elevation showing the detailed configuration of an example of the liquid crystal display of this operation gestalt is shown in drawing 1 .
0024] As for the liquid crystal display, 1st polarizing plate 16a is formed in the maximum upper layer. Formed the color filter substrate 15 in the lower layer of 1st polarizing plate 16a as an upper layer side. The color filter layer 6 which consists of a filter which penetrates only R (red), G (green), and B (blue), respectively The liquid crystal layer 1 which furthermore projects on the lower layer of the color filter layer 6 the image information formed on glass 18 the three-layer laminating HPDLC17 where a reflection factor has 2nd polarizing plate 16b in the lower layer of the liquid crystal layer 1, i.e., the lower layer of glass 18, and has the switchable reflective section electrically in a lower layer, the 2nd lower layer 1, i.e., liquid crystal layer, of polarizing plate 16b, -- and It has the structure of having the back light unit 3 which is the lighting which irradiates light in the liquid crystal layer 1 from a tooth back in the lowest layer.
[0025] Form birefringence liquid crystal, such as nematic liquid crystals, such as TN liquid crystal and STN LCD, or ****** liquid crystal, and OCB liquid crystal, may be used for the liquid crystal layer 1.
[0026] Here, the outline of the formation approach of the liquid crystal layer 1 is explained.
[0027] First, the orientation film is formed on both the substrates of the glass substrate 18 which has a transparent electrode, and the color filter layer 6 and the color filter substrate 15 which has a transparent electrode. In addition, the transparent electrode on both substrates is not illustrated in drawing 1 . Then, orientation processing is performed on the orientation film and both substrates are made to rival through a spacer. In this case, it is made to rival so that the orientation processing direction of both substrates may be intersected perpendicularly. Then, a nematic liquid crystal is poured into the gap of both substrates, and the liquid crystal layer 1 is formed.
[0028] Next, the basal principle of the liquid crystal display of this operation gestalt is explained using drawing 2 which shows the typical sectional side elevation showing the basic configuration of the liquid crystal display of this operation gestalt.
[0029] Although a liquid crystal display makes basic structure the reflective structure layer 2 equivalent to the 1 or 3 layer laminating HPDLC17 of liquid crystal layers, and the back light unit 3 as shown in drawing 2 (a) and drawing 2 (b), it may make basic structure that by which the color filter layer 6 is formed in the upper layer of the liquid crystal layer 1 as shown in drawing 2 (c) and drawing 2 (d).
[0030] Although the reflective section may be what kind of structure as long as it is the structure reversibly changed in the condition that the reflection factor of light is high and that permeability is low, and the condition that the permeability of light is high and that a reflection factor is low, the reflective structure layer 2 has the electrically controllable reflection factor shown below, and it is suitable for it that it is especially a layer containing the liquid crystal or the polymer liquid crystal using Bragg reflection.
[0031] For example, the reflective structure layer 2 may consist of shift laminated-structure layers 9 in which the liquid crystal drop layer 10 which is shown in drawing 3 (a) and drawing 3 (b), and which is the reflective section, and the macromolecule layer 11 carried out the laminating by turns. If the refractive indexes of the liquid crystal drop layer 10 and the macromolecule layer 11 differ, an ambient light 4 will be alternatively reflected in the wavelength decided a shift period as shown in drawing 3 (a). On the other hand, if an electrical potential difference is impressed to this shift laminated-structure layer 9, the refractive index of the liquid crystal drop layer 10 changes, alternative reflection can be solved, it can be in a transparence condition, and the back light light 5 from the back light unit 3 can be made to penetrate in accordance with the refractive index of the macromolecule layer 11, as shown in drawing 3 (b). In addition, it is also possible to reflect multicolor light by piling up 1st shift laminated-structure layer 9a and 2nd shift laminated-structure layer 9b from which a laminating period differs as the shift laminated-structure layer 9 is also shown in drawing 3 (c) and

lrawing 3 (d). That is, the full color display of the liquid crystal display of this operation gestalt is attained by considering ;s the configuration in which each of two or more reflective sections, such as 1st shift laminated-structure layer 9a and :nd shift laminated-structure layer 9b, reflects only the light of a specific frequency band by Bragg reflection.

0032] Moreover, cholesteric liquid crystal may be used as the reflective section of the reflective structure layer 2. A eflection factor is electrically controllable if cholesteric liquid crystal is used as everyone knows. As shown in drawing 4 a), since the cholesteric-liquid-crystal layer 7 has spiral structure, it reflects alternatively the ambient light 4 :orresponding to the one half of the pitch. Moreover, if an electrical potential difference is impressed to this cholesteric iquid crystal, spiral structure will be canceled as shown in drawing 4 (b). For this reason, the above-mentioned reflective ngine performance is lost and the back light light 5 of a full wave length band is penetrated. As an example which ealizes this, 26 volumes and 1645 - 1653 pages ("Switchable mirrors of chiral liquid crystal gels", LIQUID CRYSTAL, 1999, Vol.26, No.11, 1645-1653) can be mentioned in "switchable MIRAZU OBU chiral liquid crystal GERUZU", liquid :oulisse TARUZU, and 1999. Moreover, if the laminating cholesteric-liquid-crystal layer 8 which carried out the aminating of the 1st cholesteric-liquid-crystal 7a from which a spiral pitch differs, and the 2nd cholesteric-liquid-crystal 7b is used as a reflective structure layer 2 as shown in drawing 4 (c) and drawing 4 (d), it is possible to reflect multicolor ight like the shift laminated-structure layer 9.

'0033] Thus, to the reflective structure layer 2, the laminating of each reflective section of the reflective structure layer 2 nay be carried out in the direction of a laminating in which the laminating of the liquid crystal layer 1 and the back light unit 3 is carried out, and it may be formed in it.

'0034] Or the reflective structure layer 2 may consist of a macromolecule layer in which the reflective section as shown in drawing 5 (a) and drawing 5 (b) contains a cholesteric-liquid-crystal drop. By impressing an electrical potential difference, the spiral inside the cholesteric-liquid-crystal drop 13 is canceled, the macromolecule layer 14 containing the cholesteric-liquid-crystal drop 13 which consists of cholesteric liquid crystal of a spiral pitch which carries out selective reflection of the ambient light 4 will be in a transparence condition, and the transparency of the back light light 5 of it will be attained. Moreover, if it is a macromolecule layer containing the cholesteric-liquid-crystal drop containing two or more cholesteric liquid crystal with which spiral pitches differ, it is possible to reflect multicolor light alternatively similarly.

[0035] Next, the creation approach of the laminated structure of HPDLC which is the shift laminated-structure layer 9, and the detail of structure are explained using drawing 6 and drawing 7.

[0036] First, as shown in drawing 6 (a), the layer which consists of mixture of liquid crystal and the photosensitive matter, and liquid crystal and a photoresist matter mixolimnion 20 are formed on the substrate 19 which has a non-illustrated transparent electrode.

[0037] Next, the laser beam 21 emitted from the same laser is dichotomized, and both beams of light are made to cross in liquid crystal and the photoresist matter mixolimnion 20, as shown in drawing 6 (b). Photo-curing arises strongly alternatively in the field where laser reinforcement is strong as a result of laser beam interference. Moreover, liquid crystal deposits as a drop in the field where laser reinforcement is weak. The HPDLC layer 22 which consists of a macromolecule layer which carried out photo-curing to the liquid crystal drop layer as shown in drawing 6 (c) as mentioned above is completed. If the refractive indexes of a liquid crystal drop layer and a macromolecule layer differ, the light of the wavelength corresponding to the laminating period of a shift laminated structure will be reflected alternatively. In case photo-curing is carried out, in the case of photoresist matter which carries out oxygen inhibition, it carries out in the environment under nitrogen-gas-atmosphere evaporation or reduced pressure. The laminating period of this shift laminated structure can be decided on the wavelength and its decussation angle of a laser beam. Then, if liquid crystal and a photoresist matter mixolimnion are formed again and laser wavelength and a decussation angle are changed and exposed on the HPDLC layer 22 which drawing 6 (c) completed, the HPDLC layer of the bilayer from which a shift laminating period differs can be obtained. It can consider as the three-layer laminating HPDLC layer 17 which consists of HPDLC23 for blue which reflects blue as repeats three membrane formation and exposure as mentioned above, for example, shows a HPDLC layer to drawing 7, HPDLC24 for green which reflects green, and HPDLC25 for red which reflects red. In addition, if light carries out incidence of the transparent electrode 26 from a laminating top face as built-up sequence in this case in the case of this laminating electrically connected to HPDLC23 for blue, and HPDLC25 for red, blue, green, and red are desirable. This is because it is easy to be scattered about like the light of short wavelength. This three-layer laminating HPDLC layer 17 reflects the white light. If an electrical potential difference is impressed to this three-layer laminating HPDLC layer 17, the refractive index of a liquid crystal drop layer will change. If the refractive index of a liquid crystal drop layer and a macromolecule layer is in agreement, it cancels and selective reflection light will be in a transparence condition.

[0038] With this operation gestalt, the reflection factor of the three-layer laminating HPDLC layer 17 is high at the time of no electrical-potential-difference impressing. Therefore, a display action is possible by carrying out electrical-potential-

difference supply only in the liquid crystal layer 1, without carrying out electrical-potential-difference supply at the three-layer laminating HPDLC layer 17. For this reason, at the time of a reflective display, it is not accompanied by excessive power. Moreover, a transparency display will be obtained, if an electrical potential difference is supplied to the HPDLC layer 22 which carried out the laminating, it changes into a transparence condition and the back light unit 3 is made to turn on.

[0039] As explained above, according to the liquid crystal display of this operation gestalt, in a bright environment, a full color transparency display can be performed for a full color reflective display in a dark environment by forming the layer containing the liquid crystal or the liquid crystal polymer which used Bragg reflection as a reflective structure layer 2 between the liquid crystal layer 1 and the back light unit 3.

(2nd operation gestalt) Next, the sectional side elevation showing the detailed configuration of an example of the liquid crystal display of this operation gestalt is shown in drawing 8 .

[0040] The liquid crystal display of this operation gestalt has the composition of having the 1st polarizing plate 116a, the color filter substrate 115, the color filter layer 106, the liquid crystal layer 101, the 127 or 3 layer laminating HPDLC117 of thin film-ized glass, and the 2nd polarizing plate 116b, and having the back light unit 103 in the lowest layer sequentially from the maximum upper layer, as shown in drawing 8 (a).

[0041] Thus, in the case of the liquid crystal display of this operation gestalt, it differs from the liquid crystal display of the 1st operation gestalt in that the laminating of thin film-ized glass 127 and the three-layer laminating HPDLC117 is carried out between the liquid crystal layer 101 and the 2nd polarizing plate 116.

[0042] Moreover, at the time of a reflective display, only 1st polarizing plate 116a contributes the liquid crystal display of this operation gestalt to a display. This display mode is known as an one-sheet polarizing plate method. That is, as compared with the method which uses two polarizing plates, a bright reflective display is obtained at the time of a reflective display. In this case, twist nematic liquid crystal mode is used as a liquid crystal layer 101. The design of this twist nematic liquid crystal is stated to 1573 - 1578 pages ("Analysis of operation mode of reflective liquid crystal display devices", LIQUID CRYSTALS, 1999.vol.26, No.11, 1573-1578) in "an analysis OBU operation mode, OBU REFUREKUTIBU liquid crystal display debye seeds", and liquid crystal 26-volume 1999.

[0043] In addition, except having mentioned above,, fundamentally, since it is the same as that of the liquid display of the 1st operation gestalt, explanation of a detail is omitted.

[0044] Hereafter, the outline of the creation procedure of the liquid crystal display of this operation gestalt is explained.

[0045] The color filter substrate 115 and glass substrate which have a transparent electrode are made to rival like the 1st operation gestalt. Then, one of substrates are thin-film-ized and it considers as thin film-ized glass 127. This thin film-ization is obtained polish or by etching chemically in a glass substrate. moreover, a high polymer film etc. -- a thin film -- instead of [ of a glass substrate ] -- also using -- it is clear that it can do. Then, liquid crystal is poured in and the liquid crystal layer 101 is formed. In this case, the orientation processing direction of both substrates is adjusted so that predetermined twist nematic structure may be formed. The liquid crystal panel which has thin film-ized glass 127 as mentioned above is completed. 1st polarizing plate 116a is stuck on the top face of the completed liquid crystal panel. Moreover, the three-layer laminating HPDLC117 is stuck on a liquid crystal panel inferior surface of tongue, and the 2nd polarizing plate 116 is stuck on the inferior surface of tongue of the three more layer laminating HPDLC117. The back light unit 103 is arranged and it completes next.

[0046] Here, the reason using thin film-ized glass 127 is explained using drawing 8 (b).

[0047] Drawing 8 (b) shows the configuration for which not thin film-ized glass 127 but the glass 118 with which thin film-ization is not made was used. In the case of a reflective mold display, incidence of the ambient light 104 is carried out from across. For this reason, when a glass substrate 118 is far from the three-layer laminating HPDLC117 which is a reflector thickly, the ambient light 104 which has passed R of the color filter layer 106 will pass the adjoining pixel G as reflective display light 104a. The so-called problem of parallax arises. When there is prevention need, as the problem of this parallax is shown in drawing 8 (a), it is necessary to form thin film-ized glass 127.

[0048] In addition, in order to prevent the reflective display light leakage from a contiguity pixel, as shown in drawing 8 (c), you may consider as the configuration which makes the three-layer laminating HPDLC layer 117 between the color filter substrate 115 and a glass substrate 118, namely, is made inside a liquid crystal panel.

[0049] Parallax is not only solved by using thin film-ized glass 127 according to [ as explained above ] the liquid crystal display of this operation gestalt, but in a bright environment, it can perform a full color transparency display for a full color reflective display in a dark environment by forming the layer containing the liquid crystal or the liquid crystal polymer which used Bragg reflection as a reflective structure layer 102 like the 1st operation gestalt between the liquid crystal layer 101 and the back light unit 103.

(3rd operation gestalt) next, the sectional side elevation showing the detailed configuration of an example of the liquid

crystal display of this operation gestalt -- drawing 9 -- moreover, the fundamental configuration of the liquid crystal display of this operation gestalt is shown in drawing 10 , respectively.

[0050] The liquid crystal display of this operation gestalt has the composition of having the 1st polarizing plate 216a, the color filter substrate 215, 1st color filter layer 206a, the liquid crystal layer 201, the 218 or 3 layer laminating HPDLC217 of glass, the 2nd polarizing plate 116b, and 2nd color filter layer 206b, and having the back light unit 203 in the lowest layer sequentially from the maximum upper layer, as shown in drawing 9 (a). In addition, like 1st color filter layer 206a being the thing which it comes to form in the color filter substrate 215, although it comes to also form 2nd color filter layer 206b in a color filter substrate, since it is easy, the color filter substrate of 2nd color filter layer 206b is not shown in drawing 9 .

[0051] As the liquid crystal display of this operation gestalt is shown in drawing 10 , it differs from the liquid crystal display of the 1st and 2nd operation gestalten in that 2nd color filter layer 206b is prepared in the lower layer from between [ 202 ] the back light unit 203 and the reflective structure layers 202 equivalent to the three-layer laminating HPDLC217 (i.e., a reflective structure layer). In addition, about configurations other than ****, fundamentally, since it is the same as that of the 1st operation gestalt, explanation of a detail is omitted.

[0052] In the case of this operation gestalt, 1st color filter layer 206a and 2nd color filter layer 206b are arranged so that each pixel may have consistency mutually. That is, it is arranged so that each color pixels A, B, and C of 1st color filter layer 206a and each color pixels A, B, and C of 2nd color filter layer 206b may carry out location adjustment mutually. Thus, by arranging, as shown in drawing 10 (b), the back light light 205 from the back light unit 203 which passed the pixel B of 2nd color filter layer 206b can pass the pixel B of 1st color filter layer 206a at the time of a transparency display. In addition, generally in the case of a full color display, it is common to choose A, B, and C each color as red (R), green (G), and blue (B).

[0053] By the way, generally, the permeability and color purity of a color filter are in reciprocity relation, the color filter of high permeability serves as low color purity, and the color filter of high color purity serves as low permeability. In the case of the liquid crystal display which has one layer of color filter layers of such a property, in light, at the time of a reflective display, the time of incidence and reflective display light penetrate a color filter layer twice, and transparency display light penetrates a color filter layer once at the time of a transparency display. For this reason, although a high reflection factor is obtained at the time of a reflective display when the color filter of high permeability is used, at the time of a transparency display, color purity will become low. On the contrary, although color purity at the time of a transparency display can be made high when the color filter of low permeability is used, only a low reflection factor is obtained at the time of a reflective display. Thus, it is difficult for a color filter to reconcile the high reflection factor at the time of a reflective display, and the high color purity at the time of a transparency display with the configuration of only one layer.

[0054] With the configuration of this operation gestalt, as shown in drawing 10 (a) at the time of a reflective display, reflective display light 204a passes only 1st color filter layer 206a, and at the time of a transparency display, as shown in drawing 10 (b), the back light light 205 passes two-layer [ of 2nd color filter layer 206b and 1st color filter layer 206a ]. Therefore, as 1st color filter layer 206a, at the time of a reflective display, a high reflection factor is obtained in the thing of the property of the low color purity in high permeability by using the thing of the property of the low color purity in high permeability as 2nd color filter layer 206b, and, for example, the property that high color purity is obtained can be given at the time of a transparency display. In addition, desired permeability and color purity can be obtained by combining variously the reflection factor of 1st color filter layer 206a and 2nd color filter layer 206b, and the property of color purity, and it becomes possible to reconcile the high reflection factor at the time of a reflective display, and the high color purity at the time of a transparency display by high order origin compared with the liquid crystal display of the configuration using the color filter of one layer.

[0055] 2nd color filter layer 206b may be arrangement as it is more suitable than the three-layer laminating HPDLC217 with which to be arranged in a lower layer, i.e., drawing 9 , at the lower layer and, as for the configuration of the liquid crystal display of this operation gestalt, glass 218 and 2nd polarizing plate 216b fundamentally indicated to be to drawing 9 (b) - drawing 9 (d) as a configuration of those other than drawing 9 (a) from the reflective structure layer 202. Moreover, it cannot be overemphasized that parallax is solved if the thin film-ized glass stated with the 2nd operation gestalt is used similarly.

[0056] As explained above, according to the liquid crystal display of this operation gestalt, it compares with the liquid crystal display of the configuration using the color filter of one layer. It not only becomes possible to reconcile the high reflection factor at the time of a reflective display, and the high color purity at the time of a transparency display by high order origin, but The layer which contains the liquid crystal or the liquid crystal polymer which used Bragg reflection as a reflective structure layer 202 like the 1st and 2nd operation gestalten by forming between the liquid crystal layer 201 and

he back light unit 203 In a bright environment, a full color transparency display can be performed for a full color eflective display in a dark environment.

4th operation gestalt) next, the sectional side elevation showing the detailed configuration of an example of the liquid rystal display of this operation gestalt -- drawing 11 -- moreover, the fundamental configuration of the liquid crystal lisplay of this operation gestalt is shown in drawing 12 , respectively.

[0057] The liquid crystal display of this operation gestalt has the composition of having the back light unit 303 at order in he space division reflective structure layer 332 which has two or more fields which reflect only the light of the wavelength range corresponding to each pixel of the 1st polarizing plate 316a, the color filter substrate 315, the color filter layer 306, the liquid crystal layer 301, glass 318, and the color filter layer 306, the 2nd polarizing plate the 316b, and he lowest layer from the maximum upper layer, as shown in drawing 11 (a).

[0058] That is, as the liquid crystal display of this operation gestalt is shown in drawing 12 , the space division reflective structure layer 332 is formed in the lower layer from between [ 301 ] the back light unit 303 and the liquid crystal layers 301 (i.e., a liquid crystal layer). In addition, about configurations other than ****, fundamentally, since it is the same as that of the 1st operation gestalt, explanation of a detail is omitted.

[0059] As the space division reflective structure layer 332 is shown in drawing 12 (a), the field is spatially classified so that it may correspond to each pixels A, B, and C of the color filter layer 306, and each fields A, B, and C of the space division reflective structure layer 332 reflect only the light of the wavelength range corresponding to each pixels A, B, and C of the color filter layer 306. the case where a full color display is performed -- each pixels A, B, and C of the color filter layer 306 -- red (R) -- green -- each wavelength range of (G) and blue (B) is passed -- as -- choosing -- this -- following -- each fields A, B, and C of the space division reflective structure layer 332 -- red (R) -- green -- it considers as (G) and a configuration which reflects the light of only each blue (B) wavelength range. That is, the space division reflective structure layer 332 has a property having the property of a color filter, and the property of a reflective structure layer. Moreover, this space division reflective structure layer 332 can also be changed into a transparence condition by controlling electrically. In addition, each field of the space division reflective structure layer 332 may be constituted using an above-mentioned HPDLC component or an above-mentioned cholesteric-liquid-crystal layer.

[0060] In addition, it means being arranged by juxtaposition in the direction which carries out an abbreviation rectangular cross in the direction of a laminating in which the laminating of the liquid crystal layer 301 and the back light unit 303 is carried out to the space division reflective structure [ where each reflective section ( drawing 12 each fields A, B, and C of the space division reflective structure layer 332) is a reflective structure layer as being classified spatially ] layer 332 here.

[0061] With the above structure, as shown in drawing 12 (a), at the time of a reflective display, an ambient light 304 passes the color filter layer 306 and the liquid crystal layer 301, and reaches the space division reflective structure layer 332. This space division reflective structure layer 332 reflects only the light of the wavelength range corresponding to a color filter color. At drawing 12 (a), only the light of the wavelength range corresponding to A of the color filter layer 306 is reflected by A of the space division reflective structure layer 332. Reflective display light 304a passes the liquid crystal layer 301 and the color filter layer 306 after reflection. For this reason, light passes the color filter layer 306 twice at the time of a reflective display. However, the light of other wavelength ranges is not reflected from the space division reflective structure layer 332. For this reason, even if it uses the thing of low permeability for the color filter layer 306, color purity does not fall, without the color of other wavelength ranges carrying out color mixture. Moreover, if the space division reflective structure layer 332 is controlled electrically and it changes into a transparence condition, the back light light 305 from the back light unit 303 can perform a full color transparency display, as the space division reflective structure layer 332 is passed and it is shown in drawing 12 (b).

[0062] It may be suitable for the configuration of the liquid crystal display of this operation gestalt that the space division reflective structure layer 332 is fundamentally arranged from the liquid crystal layer 301 at the lower layer, and it may be arrangement as glass 318 and 2nd polarizing plate 316b indicated to be to drawing 11 (b) - drawing 11 (c) as a configuration of those other than drawing 11 (a). Moreover, it cannot be overemphasized that parallax is solved if the thin film-ized glass stated with the 2nd operation gestalt is used similarly.

[0063] Moreover, even if it is a configuration without the color filter layer 306 theoretically in the case of this operation gestalt, since the full color display is possible, the color filter layer 306 may be considered as the configuration prepared when color purity wants to improve more, or when the color purity of the space division reflective structure layer 332 changes with angles of visibility.

[0064] It not only becomes possible to reconcile the high reflection factor at the time of a reflective display, and the high color purity at the time of a transparency display by high order origin with the easy configuration which was used only as the one-layer color filter layer 306 by using the space division reflective structure layer 332 according to the liquid crystal

lisplay of this operation gestalt as explained above, but The layer which contains the liquid crystal or the liquid crystal oolymer which used Bragg reflection as a space division reflective structure layer 332 like the 1st thru/or 3rd operation gestalt by forming between the liquid crystal layer 301 and the back light unit 303 In a bright environment, a full color ransparency display can be performed for a full color reflective display in a dark environment.

[0065] In the liquid crystal display of each above operation gestalt, a compensating plate is made a lower layer rather than the 1st polarizing plate of the maximum upper layer, the laminating may be carried out to the upper layer rather than the 2nd polarizing plate, and it may be further arranged rather than the reflective structure layer at the upper layer. By using a compensating plate, it is possible to use display devices, such as STN LCD other than TN liquid crystal and birefringence liquid crystal, as a liquid crystal display component.

[0066] Moreover, the active-matrix drive of the liquid crystal layer of each operation gestalt may be carried out. It is possible for this to maintain a high contrast ratio at the time of reflection / transparency display in the case of large display capacity.

[0067]

[Effect of the Invention] Since the reflection factor of each reflective section has a switchable reflective structure layer electrically including two or more reflective sections which reflect only the light of a specific frequency band by Bragg reflection in a lower layer rather than a liquid crystal layer, a full color reflective display can be used in a bright environment, and a back light unit can be used for this invention in a dark environment, and it can make a full color transparency display perform, as explained above.

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[Translation done.]